

Pavement Policy Committee Final Report on

THE PAVEMENT TYPE SELECTION PROCESS

INTRODUCTION

This final report is the result of the effort made by the Pavement Policy Committee on behalf of the Division of Highways and the Wisconsin Department of Transportation concerning the selection of pavement type for highway improvement projects. The draft version of this report was completed in December, 1993 and sent out for review and comment by all Department staff and the industries during January, 1994. Since that time the committee has invested a significant amount of time reviewing the comments for development of the final report. The last step in the development was a meeting in which the representatives from the Wisconsin Concrete Pavement Association and the Wisconsin Asphalt Pavement Association were invited to express their final concerns. With the completion of this effort, it is intended that this report will replace the policies and guidelines in Chapter 14 of the Facilities Development Manual on pavement type selection for all projects in which the pavement is reconstructed or a new pavement is being built on a new grade. This report does not cover pavement rehabilitations or overlays. Future efforts will be made in the pavement rehabilitation and overlay area and brought in to compliment the contents of this report. Revisions to the Facilities Development Manual required due to this report will be made in a separate publication.

Ideally, the pavement type selected for each individual highway improvement project is the product of an analysis, resulting in the most favorable combination of economic and engineering factors expressed in terms of the lowest life cycle cost per mile of roadway that provides the desired serviceable product. Circumstances make the analysis somewhat less than ideal because inherent in the procedures is the need to make assumptions about future maintenance, materials, rehabilitations and other items in order to compare alternatives for an equal period of time. The objective of this effort was to develop the most rational, defensible, objective and uniform pavement selection procedure that can be devised considering the present state of knowledge in Wisconsin. In many cases, this requires the use of an "expert" system or consensus of the experts as the best available knowledge. When used, the "expert" system tried to incorporate as wide of a cross-section of knowledge as possible from both the Department and industry. The Pavement Policy Committee is stressing that this is the state of our pavement type selection process as of August, 1994. All policies and guidelines presented are subject to revision, refinement and/or abandonment as proven right or wrong over time. If revisions to individual policies and guidelines are anticipated in the near future or further work is required to implement the policy or guideline, it is discussed in the report.

The contents of this report encompass development of pavement alternatives, pavement design parameters, pavement performance, timing of selection, life cycle cost analysis inputs, discount rate, analysis period, pavement maintenance, and the other considerations to be used other than the life cycle cost in the pavement type selection. This report is only valid for use on highway improvement projects in which the pavement is being reconstructed or a new pavement is being built on a new grade. Future efforts by the Pavement Policy Committee will expand the policies and guidelines to include pavement rehabilitation and maintenance improvement projects.

BACKGROUND

The Wisconsin Department of Transportation developed its existing pavement type selection process, policies and guidelines in 1984. The main product of that effort was that life cycle costing of pavement alternatives was required. To go along with the new life cycle cost policies and procedures, the other considerations to be used in pavement type selection were also formulated. The Department has been using the 1984 policies and guidelines ever since, with only some minor changes to the process.

In 1991, the Federal Highway Administration's (FHWA) Wisconsin Division office did a process review of the Department's pavement type selection and life cycle cost analysis (LCCA) procedures to determine the adequacy of our processes. Due to the variability and inconsistency across the Department in the use of our current guidance, FHWA's primary recommendation was to strengthen pavement type selection procedures and exhibit consistency of input variables for the LCCA.

Due to the age of the existing policies and guidelines, the negative results of the FHWA process review and occasional scrutiny of individual improvement project decisions by both paving industries, the Division Administrator and the Pavement Policy Committee feel that the time has come to revise our pavement type selection process in order to make it more rational, defensible, objective and uniform.

An in depth review of the Department's current process, FHWA guidance and policies and other national research and initiatives indicated the following areas need to be addressed in this pavement type selection process effort:

Review and revision of the Department's current pavement type selection process. The goal being to review the current process, identify the weaknesses, and recommend revisions to the process.

Incorporation of maintenance costs into the LCCA. The goal of this effort was to review the Division's maintenance practices and cost data and develop reliable and defensible maintenance costs for incorporation into the LCCA.

Review the discount rates and analysis period currently used in the Department's LCCA procedure. These two items have not been looked at since they were established in 1984. The goal is to review current economic conditions to assure the adequacy and accuracy of these key inputs of the LCCA.

Investigate the incorporation of user delay and costs into the Department's LCCA procedure. This issue is currently a national initiative and the topic of many national research efforts. The goal is to determine if there is enough information to determine if the delay costs associated with pavement decisions can be reliably incorporated into our LCCA procedure.

All are presented in this report, with the exception of the incorporation of user delay and costs. The concept of user delay and the associated costs is a much bigger and more complicated issue. The determination of delay due to construction, maintenance, and rehabilitations of pavement structures can be done utilizing widely accepted queuing models. The point of contention continues to be the value of time for each vehicle delayed. Therefore, this issue is being put on hold until the Department can be given further guidance by FHWA or other national research efforts.

REVIEW OF THE CURRENT PAVEMENT TYPE SELECTION PROCESS

As stated previously, the goal was to review the current pavement type selection process and recommend policy and revisions to the process such that the decision to construct/reconstruct a pavement to a particular pavement type is rationally defensible.

Upon review of the current process and of the report on the 1991 process review conducted by Wisconsin Division Office of the Federal Highway Administration on the Department's pavement design and pavement type selection process, it can be concluded that the Department's current methods of pavement design and type selection is not broken or technically incorrect. However, the process does need major improvements in the form of eliminating some traditional biases by expanding the scope of alternatives for each project, increasing guidance of the process, further development of computer applications to perform the work, achieving uniformity and consistency statewide by both the Department and consultants, and making decisions based upon objective engineering criteria rather than the subjective viewpoints of individuals. To address these areas in need of improvement the Pavement Policy Committee developed the following goals:

Develop guidelines for determining the pavement alternatives to be considered for each individual highway improvement project.

Develop guidelines for the use of the pavement alternatives in the Life-Cycle Cost Analysis.

Develop guidelines for determining the future rehabilitation treatments and their service lives for each pavement alternative.

Define the "other" considerations and factors to be used in the pavement type selection process and incorporate into guidance.

Due to the complexity, size and importance of the pavement type selection process certain assumptions must be made in order to focus this report on the true issues. Discussion of certain topics, though relevant to pavement type selection, would increase the magnitude of this effort to unmanageable proportions. Therefore, in order to stay focused on the pavement type selection issue, the following assumptions are being made:

All projects are new pavements or reconstructions of the existing pavement structure. Definition of a new pavement structure is the construction of a new pavement surface (Asphaltic Concrete (AC) pavement or Portland Cement Concrete (PCC) pavement) and base on a new grade. Reconstruction of a pavement structure is defined as the removal of all existing AC and PCC surfaces and perhaps even existing base layers and the construction of new base layers and new AC or PCC surface. Simple resurfacings, thick overlays, whitetoppings, cracking and seating and overlaying of plain PCC, breaking and seating and overlaying of reinforced PCC, and maintenance treatments are all outside the realm of this report and should be considered as rehabilitations of existing pavement structures. Rubblizations of PCC pavements and mill and relays or pulverizations of AC

pavements should be considered as reconstructions of the pavement structure. This is due to the fact that these procedures entirely break up the integrity of the existing pavement structure and perform as a base layer.

The current pavement structural design method (AASHTO '72) is adequate and meets the current needs of the Department. The method, accuracy and applicability of the thickness design procedure used can always be debated, because of the many methods available. The purpose for this assumption is to eliminate another variable in the pavement type selection process. This assures us that there is one structural requirement for each pavement type when developing the pavement alternatives for each individual improvement project.

The projects are on the State Trunk Highway (STH) System. All of the inputs to the structural design and LCCA, such as traffic, loading, pavement performance, service lives, rehabilitation strategies, maintenance thresholds and costs, etc, used in this report are based upon Department data, experience and research. Therefore, our guidelines and policies will automatically be orientated to the STH System. The Department is aware that many of our policies are used by local units of government and consultants for roadways off of the STH system. The framework of the pavement type selection process outlined in this report should be able to be applied to local, county and municipal roadways as long as the accuracy and applicability of the individual inputs is assessed. The local unit of governments and their consultants must utilize their own pavement management techniques to assure the pavement decisions made are in their best interest.

Sufficient funds have been programmed for new pavement or pavement reconstruction. This sets the common ground in the pavement design selection process that sufficient funds have been allocated such that pavement reconstructions or new pavement is the only consideration. Pavement reconstructions should not be considered if the budget for a project indicates that only resurfacings or rehabilitations are possible. Setting this prior to beginning the work on the design and pavement type selection removes the biases that the budget constraints may present. This assumption does not imply that pavement decisions will be based upon initial costs, which can remove the competitiveness of our industries. All pavement decisions regarding costs will continue to be made based upon life cycle costs.

GOAL: Develop Guidelines For Determining the Pavement Alternatives

Currently the project design engineers and the pavement design engineers in each district are the primary people developing the pavement design alternatives considered for each individual project. These people compile all the necessary facts and information on the individual highway improvement project and seek the input of all the functional areas of the district and central office to develop reasonable alternatives for reconstruction of the pavement structure. For consultant designed projects, these same district representatives and consultant representatives should have similar discussions on development of alternatives. This is a critical point for all projects. The work done in developing the pavement alternatives at this point influences and impacts the future project concepts and the budgetary impacts. This has become increasingly more critical due to the fact that the pavement design/type selection is being completed much earlier in the development of the project in the past few years. Consideration of all reasonable Portland Cement Concrete alternates and Asphaltic Concrete alternates is essential at this point. It is extremely important that the engineers do not incorporate any subjective opinions or biases into the process at this point. The goal is to develop the pavement design and pavement type selection by letting the engineering criteria and life cycle cost analysis objectively evaluate all potential pavement alternatives.

Therefore, the Pavement Policy Committee has the following recommendations:

Establish the policy that all new pavement and pavement reconstruction projects will contain at least one PCC alternative and one AC alternative regardless of functional class, traffic, required structure, etc. Both pavement types will be evaluated by performing a LCCA and the other engineering criteria. The other criteria are outlined later in this report.

Work should be done to eliminate the perceived bias against thick full depth or deep strength asphaltic concrete pavements (greater than 6-inches).

Work should be done to eliminate the perceived bias against thin Portland Cement Concrete Pavements (6, 7, and 8-inches).

Requiring that at least one PCC alternate and one AC alternate will assure that each industry's product is considered for every project. This may be awkward at first due to the fact that some non-traditional pavement designs may be considered. The long-term impact may be that the Department will expand the spectrum for use of both pavement types. This will not happen overnight, but in time it is likely that thicker AC and thinner PCC pavements will be used.

The policy requiring that every project contain at least one alternative of each pavement type will create the proposal of nontraditional pavement structures. The argument can be made that having to include these now extra alternatives will increase delivery costs of the pavement design report and will simply be an exercise. However experience has shown that, if the pavement design or type selection is second guessed at a later time for

any reason, Department managers, supervisors and engineers can spend many hours rejustifying the pavement decisions made and revising plans if the type selection was changed. This policy calls for doing a thorough job the first time. It is felt that the small additional time spent doing the additional analysis initially will pay off later should the pavement type selection fall under scrutiny. Another concern in this area, now that this requirement is in place, is that we have increased the number of alternates and increased the complexity of the analysis. The goal of this effort would be to present the best PCC alternate and the best AC alternate. Our rigid design thickness procedure (FDM Procedure 14-1-10) will develop one PCC alternative. A second PCC alternative may be proposed if it falls under the requirements for a drained pavement structure. The flexible pavement design thickness procedure (FDM Procedure 14-1-5) determines the structural number required for the pavement. The procedure also gives guidance on determination of the best asphaltic pavement structure to meet the required structural number. The flexible design is also subject to other design requirements like drainage that may produce one or two additional alternatives. Therefore, the normal range of number of alternatives for an individual project is typically between two and four alternates with a maximum of six. This is certainly a manageable number of alternatives.

Expanding the spectrum of consideration for each pavement type is the key for considering AC pavements greater than six inches or PCC pavements that are eight inches or less in thickness. The number one question that arises on this issue is "Are these the results of biases or failures in the field, thus our disinclination for building them on future projects"? This question can not be answered, due to the unknown origin of these unwritten policies and "rules of thumb". Reality is that many thick asphaltic concrete and thin PCC pavements are being built by Wisconsin's municipalities and other states. Therefore, the design and construction details and specifications, the experience in constructing these pavements and an assessment of performance is available.

The process of breaking down the barriers against thin PCC pavements and thick AC concrete pavements will be led by the Pavement Research and Performance Section of the Office of Construction and will be accomplished in three basic steps. The first step will be isolating any existing pavements of these types in the State and making performance comparisons against the more traditional designs. The second step will be performing a literature search to determine if other states are designing and constructing these pavements and determining their performance history. The third will be to review all current design procedures and construction specifications to assure their accuracy and applicability to thick AC and thin PCC pavements. The MnRoads research effort being conducted by the Minnesota Department of Transportation, along with the recent research project proposed by the Department should play a strong role in incorporating design features, standards and long-term pavement performance predictions.

The first step will be conducted in concurrence with the current pavement performance modeling effort by the Pavement Research and Performance Section of the Office of Construction. This effort is scheduled for completion in December, 1994. The second and third steps will be completed and a report prepared for district and industry review by

January 1, 1995. Upon completion of the review period additional guidance will be placed in Chapter 14 of the Facilities Development Manual.

Finally, construction of a select number of highway projects utilizing these pavements is required. At that time, an intensive monitoring and reporting of performance by the efforts of the Pavement Research and Performance Section of the Office of Construction is warranted to assure that all constructability and performance concerns are addressed. This would not be a long term research effort, but merely an effort to assure that all initial concerns are addressed prior to whole scale implementation of this pavement philosophy.

GOAL: Develop Guidelines For the Use of the Alternatives in the Life-Cycle Cost Analysis

Life-cycle cost analysis (LCCA) has been accepted as the major tool to be used in the pavement type selection process. The lowest life cycle cost alternative along with the applicable engineering criteria is typically the basis for a majority of the pavement type selections. The accuracy, uniformity and consistency of all inputs and computations in the LCCA is directly related to the reliability and creditability of the analysis. It has become evident that the current guidance in the Facilities Development Manual and the tools to perform the work are extremely outdated and perhaps incomplete. A majority of the guidance on pavement type selection has not been updated since the 1984 revision of the discount rate. Due to this long period of stagnant guidance the once valuable Life-Cycle Cost Analysis (LCCA) has become a tool in the pavement type selection process that is only marginally effective. This is particularly true when the results of the LCCA do not come to the same conclusion as the designer's experience would tell them is the preferred pavement alternative. One of the observations of the FHWA in their 1991 process review of the Department's pavement design/type selection process was that there was a high frequency of evidence that the LCCA was recalculated to support a preferred pavement alternate. That led to the FHWA recommendation to provide additional guidance to improve consistency statewide among both Department and consultant reports.

The Pavement Policy Committee's recommendations do not include a complete overhaul of the current process. It is felt that significant improvements can be made by using better logic and putting more complete discussion in the individual elements of the LCCA and pavement type selection process. Putting more rigor into the individual elements of the LCCA will lead to a defensible, credible, rational and repeatable outcome. The committee's recommendations are as follows:

The Office of Construction's Pavement Section has completed and implemented the new "***Pavement Structural Design and Life Cycle Cost Analysis Computer Program***". This program designs the pavement structure, computes the quantities and estimates, develops the rehabilitation strategy for all alternatives, and then performs the LCCA. The district pavement structural design engineers and other personnel have been trained and are incorporating the program into their work. Also, a large cross-section of consultants received and were trained in use of the program in February, 1994. The Pavement Policy Committee recommends that it becomes policy that this program be used in the development of all pavement design reports for all highway improvement projects. The manual on the operation of the program is published in the Facilities Development Manual. Copies of the "Pavement Structural Design and Life Cycle Cost Analysis Program Manual" are available upon request from the Pavement Research and Performance Section of the Office of Construction or from each District office.

The advantages of using this program include:

1. Provides uniformity of reporting.

This program, along with the outline for pavement design reports in FDM Chapter 14 Procedure 14-1-3, will provide uniformity of the format of all reports developed for the Department regardless of the author. The benefit of this is expected to be a reduction in development time of a report as well as review time.

Clearly shows numbers used and assumptions made during the structural design and the LCCA. The display of all assumptions such as costs, material unit weights, service lives, etc leave the approval authority and reviewers totally informed. This will cut down on the intensity of reviews as well as eliminate second guessing on these items.

Presents the LCCA more clearly. Program output contains all the necessary information in a logical sequence.

Computations on all reports will be performed consistently from report to report, district to district, consultant to consultant and consultant to district. Computation of quantities, estimates, and all engineering calculations will be done by the program. This eliminates the natural variability that occurs from person to person, the method, the experience and the level of training.

Time savings in terms of automating the design and LCCA process, as well as time savings in review of work performed by consultants.

Will function as a vehicle to update districts and consultants on new pavement design guidelines and policies. All new material will be incorporated into the Facilities Development Manual in conjunction with the issuance of a new version of the program. The intent is that the program be a dynamic tool that changes with our forever changing pavement design technologies, policies and guidelines.

2. Make revisions to the flexible design process that have been subject to scrutiny and that have the ability to cause variation of results across the state

The area of concern under this recommendation centers around the use of the structural coefficients of the individual pavement layers. The Pavement Policy Committee and the Department's Pavement Design Engineers recommend that the following structural coefficients should be used on new or reconstructed pavement structures:

STRUCTURAL COEFFICIENTS

<i>Material</i>	<i>Coef.</i>
New Asphalt Concrete	0.44
CABC	
Crushed Stone	0.14
Crushed Gravel	0.10
OGBC #1	
Crushed Stone	0.14
Crushed Gravel	0.10
OGBC #2	
Crushed Stone	0.14
Crushed Gravel	0.10

<i>Material</i>	<i>Coef.</i>
Concrete Base Course	0.35
Asphalt Base Course	0.34
Cement Stabilized OGBC	
Crushed Stone	0.14
Crushed Gravel	0.10
Asphalt Stabilized OGBC	
Crushed Stone	0.14
Crushed Gravel	0.10
Rubblized PCC	0.20-0.24
Milled and Relayed Asphaltic Concrete	0.14-0.25
Pulverized Asphaltic Concrete	0.14-0.25

Breaker Run or not counted as structure crushed stone 0.14 if it is known that it is crushed gravel 0.10 going to be lost to poor subgrades

Granular Subbase Maximum of 10% of SN

One issue that continues to present itself is the use of a crushed stone or crushed gravel coefficient when it is possible that either material could be used on a project. The Materials Engineers in the district is the key person in this decision. It should be this person's responsibility for determining the most likely aggregate source and/or type that would be used on a project. Their determination should be reflected in the proper selection of a structural coefficient. It is very likely that there will be projects in certain parts of the State in which this determination will be very difficult. In this case, it is recommended that the lower structural coefficient for crushed gravel be used. This assures the Department that an underdesigned pavement will not be built. The Wisconsin Asphalt Pavement Association has pointed out that if the Department designed for

crushed gravel due to local aggregate sources and it is proposed to actually build the project with crushed stone that value engineering principles could apply. The Department is in agreement that this is an acceptable application of value engineering.

There have been many discussions in the past on whether open graded base course (OGBC) should be given credit for structure in an AC pavement due to its main function of draining the pavement. The Department has done limited California Bearing Ratio (CBR) testing on OGBC's. The results show that CBR's for these materials are typically in the 70's. Crushed aggregate base course will typically be in a range from 50 to 70. Therefore, we can conclude that when OGBC is confined, it is as strong or stronger than crushed aggregate base course. Confinement can be defined as the presence of a pavement layer above the OGBC. Based on this, OGBC will be considered as a structural layer in the Department's flexible pavement design procedure.

Coefficients for Milled and Relayed Asphaltic Concrete and Pulverized Asphaltic Concrete have been added to this report. Department experience has shown that this material can be very variable in both strength and stability, thus the range for structural coefficient. Inherent with these types of operation is the fact that regardless of the thickness of the existing asphaltic concrete one to two inches of the existing base is ground up along with the pavement producing a blend of pavement and base material. If a thin AC (3 inches) is being milled and relayed or pulverized and existing one to two inches of base is being mixed in (producing a relative equal amounts of each material), the net effect is essentially a crushed aggregate base course or a material with a structural coefficient of 0.14 or 0.10. On the other hand, if a thick AC pavement (6 inches or greater) is subject to the same operation (producing a blend of predominantly pavement material), the net effect is much greater than a crushed aggregate base course. Therefore, structural coefficients as high as 0.25 can be utilized for this material. The other controlling factor in the range for this material is whether the existing aggregates are crushed gravels or crushed stones. The relationship for moving within the range would be as previously outlined for crushed aggregate base course.

The use of breaker run on a project must be documented in the pavement design report. The most common usage of the material is to bridge poor soils in order to facilitate construction of the crushed aggregate base course layer. In this case, the material should not be accounted for having strength in the thickness design. There have been other cases where breaker run material has been used and have been given credit for structure in the design. This must be considered on a project by project basis. The rule of thumb being that the material must be able to contribute long term structure to the pavement.

The stabilization of open graded base course is not given any additional credit towards the structure. This is because the stabilized OGBCs have been designed to just facilitate construction of the pavement surface (PCC or AC) with a minimum amount of stabilization required. The amounts of stabilization that have worked well in the past is 2.5% Asphaltic Material by weight for asphalt stabilized OGBC or 200 pounds of cement per cubic yard of cement stabilized OGBC.

The structural coefficient for rubblized PCC pavements also contains a range. The specification for rubblization contains a range of the size of particle of broken PCC. The rubblization method and the type of foundation are very dependent upon the level of breakage and size of material achieved. Based upon knowledge to date, if the PB-4 sonic breaker is used along with the presence of a good sound base and/or subgrade beneath the PCC being rubblized, the level of breakage achieved is on the smaller side of the specification typically used by the Department. In this case the 0.20 structural coefficient is warranted. As base and subgrade conditions change, more of the breaking energy is absorbed by them and the level of breaking is reduced and larger pieces on the larger side of the specification are the result. This will produce a rubblized layer with slightly higher structural coefficients. Consideration of rubblization on any project should be based entirely on the base and subgrade conditions beneath the existing PCC pavement. If the PCC is sitting directly on subgrade or the base has been significantly contaminated by the subgrade, rubblization is not recommended. It will produce very large and unacceptable breaking patterns not meeting the Department's specifications. The pieces produced are so large that they will not facilitate placement of the new pavement layers above them.

The structural coefficient for Concrete Base Course has been changed to 0.35. The coefficient historically used by the Department has been 0.23, 0.20 or 0.15. The historical numbers were based upon 7-day unconfined compressive strength tests of greater than 650 psi, 400-650 psi, and less than 400 psi, respectively. The 7-day unconfined compressive strength for Concrete Base Course produced under the Department's current specification very rarely falls beneath 1800 psi. The AASHTO '93 Guide for the Design of Pavement Structures would estimate the structural coefficient of 0.35 for an unconfined compressive strength of 1800 at 7 days. Upon further investigation of the difference in structural support for this material, it was discovered that the Department was previously using numbers based upon results of the AASHTO Road Test, in which the material used was very similar to the cement stabilized sand the Department used in the 1960s on the interstate system.

The structural coefficients outlined above will be incorporated into Procedure 14-1-5 of the Facilities Development Manual on the thickness design of flexible pavements.

3. Develop specific guidelines for development of the quantities and estimates input into the LCCA

The current guidelines do not contain any guidance on the different factors and methods used to compute the quantities and estimates input into the LCCA. It is well known that the unit weights of materials, method of computation, unit costs, and service lives used can significantly effect the outcome of the LCCA. In an effort to achieve consistency and to return as much objectivity to the LCCA as possible the following items should be added to the guidance in the Facilities Development Manual and the new computer program:

The following unit weights are recommended for each material for use in the quantity computations in the Pavement Design/life Cycle Cost Analysis computer program by the

Pavement Policy Committee and the Department's Pavement Design Engineers in both the Districts and Central office:

MATERIAL UNIT WEIGHTS FOR NEW PAVEMENTS

<i>material</i>	<i>unit weight</i>
AC PAVEMENT	110 lbs./square yard/inch
CABC	2.0 TONS/cubic yard
OGBC #1	1.5 TONS/cubic yard
OGBC #2	1.75 TONS/cubic yard
Breaker Run	1.75 TONS/cubic yard
Shoulder Gravel	2.0 TONS/cubic yard

These unit weights have been verified by the Materials Science Section of the Office of Construction as statewide averages. The goal is uniformity and consistency statewide. However, it is understood that unit weights will vary across the state. If unit weights other than those outlined above are used it must be documented in the report and applied consistently for all projects in the district. It is recommended that each district review the above unit weights for applicability to their district. Any variations should be documented and then applied on all projects in the district. This will require communication to all consultants doing work for the district. The default values in the Facilities Development Manual guidance and the Pavement Design and Life Cycle Cost Analysis Program will be the values shown above.

During development of this report there was a lot of discussion on applying the above unit weights to a theoretical cross section or adjusting them based upon common overruns during construction. The reasons for the common overruns were investigated and it was concluded that they were too numerous and variable to be able to quantify in this effort. There were simply too many variations and reasons from project to project. Most of the overruns seem to deal with accuracy of construction operations in building according to the typical section, excavation below subgrade, shoulder quantities, intersections, etc. All things out of control of the design engineer and pavement design engineer. Therefore, in order to achieve uniformity and consistency in estimating quantities in a predictable manner for all highway improvement projects the Pavement Policy recommends use of the theoretical cross section and the material unit weights previously outlined. It is also recommended that the pavement design engineer forward copies of the computations and material unit weights used in development of the

pavement design report to the design engineer for use in the P.S. & E. This would build some consistency between the two times in which pavement quantities are computed for a project.

Standardization of the method of computation of quantities is required. This is an important step in achieving consistency and uniformity in the LCCA. With complete implementation of the "Pavement Structural Design and LCCA Computer Program" all quantities are computed in a consistent manner statewide by Department staff and consultants. The method of computation is outlined in Chapter 14 of the Facilities Development Manual Procedure 14-1-25.

"The Pavement Structural Design and LCCA Computer Program" will ask for bid item costs in order to complete the estimate used in the LCCA. Original versions of the program had the average bid item costs for the preceding calendar year built into the estimate computations as default values. However, reliance on average bid item costs can be dangerous and produce estimates that are not reflective of individual projects. Consequently, at request of the District Pavement Design Engineers and the industry representatives the average bid item costs were removed from the program. Accurate bid item costs based upon district experience, quantity of an item, size of project, location, availability of material, etc is absolutely essential for each project. These bid item unit costs will be displayed on a separate sheet in the program printout for inclusion in the pavement design/type selection report. This is an important part of establishing legitimacy and accuracy to the LCCA procedure. Therefore, it will be a required exhibit in every pavement design/type selection report. It will be the responsibility of the Pavement Design Engineer in each district to assure the accuracy of the bid item costs in their own reports as well as the consultant reports they review. This type of information should be requested by the consultant or made available to the consultant prior to development of the pavement design/type selection report.

Guidance on the service life of a pavement currently does not exist in Chapter 14 on Pavements in the Facilities Development Manual and must be developed. The FHWA process review completed in 1991 indicated large variations in the use of service lives exist statewide. The ultimate goal is to let the data in the Department's Pavement Management Decision Support System govern the service lives used in this work in the future. However, the pavement modeling effort currently underway by the Pavement Research and Performance Section of the Office of Construction is not scheduled for completion until November, 1994. Therefore, the use of interim service lives is required. The Pavement Policy Committee and the Department's Pavement Design Engineers recommend the following service lives for new and reconstructed pavements:

PAVEMENT DESIGN SERVICE LIVES

Pavement Type	Base Type	Years to 1st Rehab	Years to 2nd Rehab
Asphalt Concrete Pavement	undrained	12-16	10-12
	drained	15-20	10-12
Jointed Plain Concrete Pavement with dowels	undrained	20-25	10-15
	drained	25-32	10-15
Continuous Reinforced Concrete Pavements	undrained	20-25	12-16
	drained	25-32	12-16

The above service lives are for new and reconstructed pavement structures. It is understood that there are many variables that affect service life (e.g. age, ESALs, climate, traffic, location, district, subgrade soil type, aggregate type, and other engineering criteria). These are things that we inherently know, but do not have the data to prove as fact. This is the basis behind the pavement modeling effort. First, it is hoped that the effort will better define service life. While the other major goal is to determine the most important factors influencing service lives. This is of particular importance when you consider that the AASHTO method is based entirely on loading and none of the other factors listed above. The key objective is to determine service lives and the need for a rehabilitation or maintenance treatment based upon pavement condition, rather than budget or the traditional planning thresholds. Until the effort is complete it is recommended that the service lives outlined above are used in the interim period.

These service lives outlined above cannot be used blindly. The choice of the particular service life should be based on engineering criteria such as subgrade support, subgrade drainability, past pavement performance on the project, etc. All of the criteria for choice of a service life should be documented in the individual project's pavement design report. For example, a pavement structure built on a coarse grained, well drained sand is expected to perform better than the same pavement built on a impermeable clay, given all other conditions are equal. Criteria such as this should be used to justify the chosen life within the service life range. However, it is expected that if the high end of the range is used for one pavement type, it would be used for the other as well. It is general consensus that use of the opposite ends of the ranges between pavement types would be very rare and subject to immediate scrutiny. More definitive guidelines on the different engineering

criteria that influence the service life of a pavement will hopefully be revealed in the pavement modeling effort, so that this area can be expanded.

The definition of a drained pavement is a pavement designed to minimize moisture induced damage by draining free water from the pavement through utilization of an open graded base and edgedrain system. The relationship of service lives of drained versus undrained pavements is something that is still unproven by the Department's research. Therefore, the Department must continue to buy into the theories of drained pavement, in regards to additional life by the additional investment of open graded base course and the edgedrains. To account for the increased life of drained pavements in the LCCA a percent increase in life for both pavement types must be established. For the interim period a percent increase in service life of 25 percent is recommended. Therefore, service lives of a drained and undrained alternates of the same pavement types should not differ from each other by more than 25 percent in the LCCA.

The service lives of the drained pavement rehabilitations are the same as the undrained rehabilitations. If the drained pavements are allowed to deteriorate to the same level of distress as the current undrained pavements, it can be argued that the performance of the rehabilitations would be equal. Prediction of the performance of the initial construction of a drained pavement structure cannot be done beyond the theories we are currently buying into. There are many questions about the condition of the drainage layer, pipe, and outlets at the end of the initial service life of the pavement. Therefore, it is recommended that the rehabilitation lives be equal for drained and undrained pavements.

GOAL: Develop Guidelines for Rehabilitation Treatments, Service Lives, and Use in the LCCA

The introduction of future costs in the form of rehabilitations of the pavement alternatives being considered for a project is one of the key components of the LCCA. In the past, the rehabilitation strategies and their service lives used in the LCCA have been variable. The objective is to establish the most probable sequence of rehabilitations for each pavement type. This assumes that the initial pavement and the subsequent rehabilitations all perform as expected and are scheduled in accordance with the typical planning and pavement management thresholds. Following those thresholds would mean that the most probable sequence of rehabilitations would be used. This definition of most probable sequence continues to be a problem. Reality is that the proper engineering decision for the rehabilitation will be made in the future. At that time new technologies and different alternatives may be contrary to the most probable sequence of rehabilitations discussed here. However, in order to build uniform, consistent, repeatable and a defensible process, the most probable sequence of rehabilitations based upon our best knowledge today is required. Without it a large number of possibilities and number of alternatives could continue to be a problem in our process. Therefore, the Pavement Policy Committee recommends the use of the rehabilitation scenarios developed by the Department's Pavement Design Engineers. They are as follows:

TYPICAL REHABILITATION SCENARIOS AND STANDARD SEQUENCES

<i>Initial Construction</i>	Asphalt Concete on Granular Base	Asphalt Concete on Granular Base	Jointed Plain Concrete Pavement	Jointed Plain Concrete Pavement	Continuous Reinforced Concrete
<i>Initial Construction Expected Service Life (years)</i>	12-16 (undrained), 15-20 (drained)	12-16 (undrained), 15-20 (drained)	20-25 (undrained), 25-32 (drained)	20-25 (undrained), 25-32 (drained)	20-25(undrained), 25-32 (drained)
<i>1st Rehab Option</i>	Overlay	Overlay	Repair and Grind	Full Depth Mill and Overlay	Repair and Overlay
<i>1st Rehab Expected Service Life (years)</i>	10-12	10-12	10-12	10-15	12-17
<i>2nd Rehab Option</i>	Mill and Overlay	Full Depth Mill and Overlay	Repair and Overlay	Repair and Overlay	Mill, Repair and Overlay
<i>2nd Rehab Expected Service Life (years)</i>	10-12	12-16	10-15	10-15	12-17
<i>3rd Rehab Option</i>	Mill and overlay	Mill and overlay	Mill, Repair and Overlay	Mill, Repair and Overlay	Mill, Repair and Overlay
<i>3rd Rehab Expected Service Life (years)</i>	10-12	10-12	10-15	10-15	12-17

The three scenarios of rehabilitation standard sequences presented are for the pavement structures considered as the standard new or reconstructed pavement structures. Continuously reinforced concrete is still considered a feasible alternative. Our design manuals still recognize it as such. In recent history, the Department has not built CRCP's due to the problems of justifying it from an economic/cost effectiveness standpoint.

The standard sequences for the remaining pavement types that the department has built in the past, Jointed Reinforced Concrete Pavement, Jointed Plain Concrete Pavement without dowels and Asphaltic Concrete Pavement over rigid base, will be developed for the overlay and rehabilitation design process. They will be required in order to evaluate the proposed overlay or rehabilitation of these pavements against reconstructed pavement structures.

MAINTENANCE COSTS

The remaining future costs to be introduced into the LCCA are maintenance costs. The goal of the Pavement Policy Committee was to review the Division's pavement maintenance practices and cost data in order to develop reliable and defensible maintenance costs for incorporation into the life cycle cost analysis.

Currently, the practice of using maintenance costs in the LCCA is a usually not done. This is due to two reasons. The first is that no reliable costs are available for use by the district pavement design engineers. Secondly, due to unavailability of costs, the engineers and their districts have made a conscious choice not to include spurious or inaccurate costs.

It was quickly determined that it was not possible to use historic maintenance costs. The cost data is not stored in a format that can separate maintenance costs by age and type of pavement other than generic PCC or AC. Therefore, an "expert system" was adopted. From the Office of Maintenance's "Level of Service" Study, the maintenance operations being performed and the associated costs were analyzed. The question was asked, "Based upon the current state of knowledge of pavement design, construction and performance when should the Department expect to be doing maintenance and what type of maintenance should be done based upon today's standards?" From that question the maintenance operations and costs and schedules were developed. This expert system of maintenance costs is simply the best we have and the only way to incorporate maintenance costs into the LCCA at this time. The Office of Maintenance and the Bureau of Program Management is working on the development of an accounting system to get a better handle on maintenance cost by individual section of highway, pavement type and pavement age. Until this is completed, we will have to use this system.

Maintenance activities and costs are provided under the following assumptions:

1. The maintenance cycle begins with a new pavement surface or the reconstruction of the pavement structure.

2. Costs of shoulder maintenance is included in the costs outlined below.
3. The proposed maintenance treatment sequences and cost estimates should be considered "typical" for any location throughout the State. Localized soil conditions, cost variations, traffic volume and mix, aggregate and material properties and qualities, etc. have been considered and accounted for to arrive at this statewide "average" information.
4. Maintenance costs presented are estimated costs based on anticipated maintenance activities, not actual maintenance costs based on past history.
5. Maintenance costs are presented per lane mile. The costs must be adjusted for the number of lanes being proposed for the project.
6. Due to the limitations of the data, the costs of maintenance of asphaltic concrete could not be separated out by base type (concrete or granular).
7. Maintenance costs cannot be separated by drained or undrained pavement structures. This is due to the lack of maintenance history on drained pavements.
8. Maintenance costs reported for each pavement type occur once in the time frame shown.

Portland Cement Concrete Pavement Maintenance Costs

Years From New Construction	Maintenance Activity	One time Cost per Mile
0-10	None	0
10-15	Minor Joint Repair	\$2000
15- 1st Rehab	Minor Joint Repair	\$4000

As outlined in the section on service lives and the typical rehabilitation scenarios and standard sequences, a major rehabilitation of the rigid pavement structure would occur between year 20-25 for an undrained pavement structure and year 25-32 for a drained pavement structure. If the pavement is overlaid at this point, maintenance begins with the asphaltic maintenance cycle outlined below. If the rehabilitation was a repair and diamond grind, two cycles of the minor joint repair at \$4,000 per lane mile would be anticipated for the life of the rehabilitation.

Asphaltic Concrete Pavement Maintenance Costs

Years From New Construction	Maintenance Activity	One time Cost per Mile
0-3	None	0
3-5	Crack Sealing	\$1000
5- 1st Rehab	Crack Sealing and Repair	\$1250

As outlined in the previous sections of this report a major rehabilitation in the form of an overlay or a mill and overlay in the time period between 12-16 years for an undrained asphaltic concrete pavement and 15-20 years for a drained asphaltic pavement. Upon completion of the rehabilitation the maintenance cycle previously outlined would start over.

DISCOUNT RATE AND ANALYSIS PERIOD FOR THE LCCA

The discount rate and analysis period currently used by the Department was set in 1984 when the first policies on life cycle costing of pavements were formulated. Due to these two issues not being addressed in a decade, the Pavement Policy Committee hired an economics consultant, University of Wisconsin Economics Professor Dr. Donald Harmatuck. Dr. Harmatuck's goals were to study and recommend the values for discount rate and analysis period that should be used in 1994.

Dr. Harmatuck had the following recommendations and conclusions concerning analysis period:

In Wisconsin, the analysis period for high volume urban highways is 30 to 50 years and for high volume rural highways is 20 to 50 years. In practice, the period adopted by WisDOT for evaluating alternative pavement designs is fifty years. Relative to other states, this is a long period. AASHTO (1993) suggests an evaluation period from 30 to 50 years. The main advantage of Wisconsin's period is that it permits a full cycle of initial construction and rehabilitations and permits a comparison of pavement types without the need to calculate arbitrarily estimated residual values. If unrealistic residual values are calculated, they have less of an effect upon the overall results.

The analysis period for life cycle costing of mutually exclusive alternatives can be set in two ways: (1) the same length period for all alternates under consideration or (2) the length of each alternative's analysis period be set to a full cycle of reconstruction and rehabilitation for each alternative. If cost comparisons are base upon net present values, the same length period should be chosen for all alternatives. The period should be sufficiently long to avoid biases to arbitrarily truncating costs or arbitrarily estimating salvage values. Wisconsin's current fifty-year period is well suited for this net present value comparison's of alternatives. Costs occurring after fifty years is not likely to be

significant in present value terms. However, a comparison of alternatives using uniform average annual costs (UAAC) for a fixed analysis period may lead to biased results unless that period encompasses a full cycle of reconstruction and rehabilitation of each alternative.

Dr. Harmatuck had the following recommendations and conclusions concerning discount rate:

When the low cost alternative at the current five percent discount rate is, say, 20 percent lower than competing alternatives, discount rate variations do not affect choice of low cost alternative. That is, the low cost alternative remains so over the three to seven percent range. A reasonable policy then is that a five percent discount rate be continued to be used. Only if alternative costs are within 15-20 percent, should a sensitivity on the discount rate be done. If the results of the sensitivity are highly dependent upon the discount rate, one needs to determine from where the resources for the project are coming. If resources are obtained from increased taxation, a low discount rate may be justified. If pavement projects are undertaken at the expense of other highway projects, a discount rate above five percent should be used.

THE LCCA DECISION

The life cycle cost analysis decision for a new pavement or pavement reconstruction project will be made under the following criteria:

The discount rate shall be five percent.

The analysis period shall be fifty years.

The project costs evaluated in the LCCA will be pavement related costs and those additional costs that are associated with the pavement design and the uniqueness of a pavement alternative. Total project cost estimates inserted in as the initial construction costs are not acceptable. Total project costs contain too many non-pavement items and costs that can change the outcome of the pavement related economic decision.

The pavement decision will be made on a per mile basis. This will allow for a consistent criteria in the pavement decision.

The economic decision will be based upon total net present value life cycle costs or the equivalent uniform annual costs.

The LCCA decision will be made on the absolute difference in the net present value or equivalent uniform annual costs. The Pavement Policy Committee is recommending this policy based upon the fact that every input in the LCCA has been evaluated and defined in this report. Therefore, the results of the analysis should be the best possible.

It is anticipated that a majority of the pavement type selections will be made based upon the results of the LCCA and it's low cost alternative. However, it is important to remember that the LCCA is a tool in the pavement type selection process. The economic decision must be measured against the other engineering considerations for each individual project.

GOAL: Define the "Other" Considerations and Factors to be Used in the Pavement Type Selection Process

In 1984, the Department began requiring that pavement alternatives be evaluated by life cycle costing. At the same time the Department also developed a number of engineering criteria that could be weighed along with or override the results of the life cycle cost analysis. These criteria are of particular interest because they could be used to overrule the results

of the LCCA, in which the low cost alternative would usually be the pavement type selection. Due to the outdated nature of the current guidance on the use of other considerations and factors influencing a pavement type selection in Procedure 14-1-36 of the Facilities Development Manual, the Pavement Policy Committee recommends that the existing guidelines should be reviewed and rewritten in its entirety. The committee reviewed the matrices previously developed by them on comfort, convenience and safety and developed and recommended new factors for consideration. The goal was to take out subjectivity and put back factors that could be judged based upon rational, objective and defensible criteria. One intent for establishing these criteria is to break a tie when the LCCA is equal for two alternatives. However, the main intent of these "other" considerations and factors is to provide a uniform basis for justification for selection of an alternative other than the lowest cost alternative in the LCCA. In either case, a strong argument and presentation of all the pertinent facts for the basis of the decision must be thoroughly and completely documented in the pavement design report. The following "other considerations" bring additional cost and quality considerations to bear. The proposed guidelines are as follows:

CONSIDERATION OF OTHER FACTORS

Life-cycle cost analysis is only one of many potential criteria on which to base a selection of pavement type. Ideally, the alternative pavement types analyzed by life cycle cost analysis will have equivalent capabilities for carrying traffic. However, there are other factors which can also affect the selection of a specific pavement alternative. Below is a list of some of these other factors:

1. Impact to urban areas from pavement generated noise. The noise generated by the pavement/tire interface on high volume urban roadways and urban freeways should be assessed for its impacts on abutting properties and residents. In cases where the noise analysis predicts noise levels that require mitigation by the construction of noise barriers, the pavement selection can be very important. The results of a formal noise analysis for the project must be discussed and shown in the report as documentation for the use of this "other" factor. The use of this criteria does not imply that a noise analysis is required for a project, nor does it imply that an asphaltic concrete pavement is the preferred alternative because of noise. This would be used on urban freeway or other urban roadway projects where noise has already been identified as a problem during the environmental stage of the project. Therefore, if the results of the standard FHWA Noise

Model indicates that there is no noise problem, it is recommended that noise not affect the pavement type selection.

2. Surface friction characteristics. The predicted surface friction life and an assessment of its relationship to the pavement design life. The loss of surface friction prior to its first rehabilitation based upon pavement type, aggregates, traffic, etc. will be the most common discussion under this item. Also, the impacts of importing aggregates to improve friction should also be discussed as well as introducing the additional costs into the life cycle cost analysis.

3. Delineation. Positive identification of lanes or roadway features including joint patterns, pavement marking, color contrast, shoulder type, etc. Urban roadway lighting impacts could also be addressed under this item.

4. Longevity. Pavement service lives and their relationship to the details of the specific projects. The impacts of longevity have already been addressed in the service lives used in the LCCA. However, the use of this item as a tie breaker should analyze project specific details where pavement type selection may play an important role. Examples could be minimizing the impacts of the number of traffic disruptions, to developing areas, to environmentally sensitive areas, to an urban area, etc.

5. Maintenance Minimization. Anticipated maintenance and the timing of the maintenance are consistent with project goals and objectives.

6. Construction Duration. The length of time to construct the project is consistent with project goals, objectives, construction staging, traffic handling, etc. User costs and delays may play a big role in addressing this issue.

7. Budgetary Issues and Initial Costs. The pavement type selected is in agreement with the availability of capital necessary for optimum treatment. Emphasis has always been and should continue to be that the pavement type selection cost comparison should be based on the life cycle costs (typical analysis period of 50-years). Initial costs should only be used in the extreme cases where the budgeting constraints of the project force the use of initial costs in order to build the project. If this is a pavement reconstruction or new pavement construction, budget should not be a problem because the dollars should have been programmed accordingly. This is only a problem in the rare instance when a mistake or project concept changed, such that inadequate dollars has been programmed. This should be very rare. The goal of the pavement design engineer should be to make the best pavement decisions regardless of budget. If budget becomes a constraint as identified by district management, it should be identified as such in the pavement design report, particularly when the most cost effective pavement alternative is not chosen.

8. Historical Performance of Pavements on or Adjacent to the Project. Documented pavement performance history of a pavement type performing well or poorly on the project or adjacent roadways. Care must be taken to insure that this type of comparison is relevant to the project and that no new variables are introduced. Discussions of soil types,

locally available aggregates, material characteristics, etc relevant to the project area could be discussed under this item.

Due to the length of time that the existing guidance has been in place on the "other" considerations and factors to use in pavement type selection, the Pavement Policy Committee also makes the following recommendations:

1. The opportunity for recycling, conservation of materials, and utilization of local materials as pointed out in the current guidelines is common practice today and the effects of these items will be reflected in the LCCA. Recycling of existing pavements as aggregate for new pavements, as base or subbase has become a very valuable and innovative part of pavement engineering and highway construction that both the Department and industry are becoming increasingly comfortable. Because of this, the once traditional extra costs of recycling has disappeared or been minimized. Therefore, it should no longer be a consideration in the pavement type selection process. This is reinforced in Wisconsin State Statute 84.078, which requires the Department to recycle whenever possible. The additional costs of recycling are acceptable to the public. Therefore, recycling should automatically be considered on a project and reflected in the LCCA.

2. Continuity of pavement type is a consideration in the pavement type selection process that should be eliminated. The committee feels that this is a weak argument in the pavement type selection process that does not promote responsible use of highway funds. It has been argued that the continuity argument breaks down in the urban projects, and that it is indeed an important part of the decision. The subjectivity of the designer can greatly influence the use of the continuity argument. If the goal is to develop a rational and defensible process, and to select and build the most cost effective pavement, decisions should not be made on continuity. Continuity must be broken down into the eight "other considerations" outlined in this report. It is felt that continuity in itself is not justification, rather that the other considerations may indeed preserve continuity.

3. Competition among industries is not something that should be considered when making a decision on an individual project. To the degree that competitive balance is an issue, it can only be addressed at the overall program level. The Department will continue to have the goal of maintaining a consistent program.

4. Incorporation of experimental factors should also be eliminated from consideration. Pavement design reports are commonly completed 3-5 years in advance of construction. It is felt that technology is currently moving too fast to predict what experimental features could be available for construction at the time the report is written. An excellent example of this is the Stone Matrix Asphalt technology. It came upon us very fast, and to effectively evaluate the applications for its use, a research project was quickly established and the technology incorporated into projects as change orders and/or at the P.S. and E. stage of the project. It would take up to three years to incorporate a new technology into a

project if the decision to use it was established in the pavement design/type selection stage of the project.

5. Local government preference is a commonly used consideration for urban projects. And, it appears to be a source of continual debate from both industry standpoints. The goal is to have a pavement policy that is rational objective and defensible and to select and build the most cost effective pavements. Then, local preference should not be a consideration for pavement type selection. The local unit of government and it's engineers must break down the reasons for the preference. It may be very likely that the eight other considerations outlined in this report may be hidden within the preference. The Pavement Policy Committee recommended to the Bureau of Program Management that they address this issue in their 1994 revisions to the Department's cost sharing policies. They have responded and are in the midst of updating their policies to reflect this. The new cost sharing policies will be based upon the difference in the present worth costs presented in the life cycle cost analysis. If the municipality chooses to construct the more expensive pavement based upon life cycle costs, rather than initial costs, then they will be responsible for the difference. Basing cost sharing policies on life cycle costs underscores the importance of good reliable costs being used in the LCCA. The training and support must be given to the district pavement design engineers in preparing the costs inserted into the analysis.

6. The Analysis Matrix for Ranking Project Alternatives as outlined in the current guidance in Procedure 14-1-36 in the Facilities Development Manual should be abandoned. The procedure of assigning relative importance and level of satisfaction of criteria can become a number game that can be a poor means for justifying a preferred alternative. Instead, it is preferred that there be a discussion and documentation of the facts and engineering criteria used to establish the reasons for a type selection when the LCCA is equal or the selection is contrary to the LCCA.

THE PAVEMENT TYPE SELECTION

The final selection of pavement type for an individual highway improvement project in which a new pavement is being constructed or the existing pavement is being reconstructed is based upon the results of the LCCA and the eight "other considerations". It is anticipated that a strong majority of the selections will be based entirely upon the LCCA in which the alternative with the lowest life cycle costs will be selected. The "other considerations" were developed to separate alternatives that have equal life cycle costs, or to override the results of the LCCA because of a strong argument or position presented by one or more of the "other considerations".

It was previously stated in this report that the "other considerations" were qualitative measures of a pavement alternative. The one or more of the considerations can be used to overrule the results of the LCCA in any situation based upon the characteristics and needs of an individual project. In addition, the Pavement Policy Committee is recommending that it be policy that all eight other considerations must be addressed in the pavement design report when the results of the LCCA indicate that the lowest PCC alternative and the lowest AC alternative are within five percent of each other. This will assure that when life cycle costs are so close that all important considerations for a pavement type selection of an individual project are realized and presented in the report. Also, the documentation of the unimportant considerations will erase the doubt of whether they were addressed.

Selection of an alternative other than the lowest life cycle cost alternative will immediately leave the Department vulnerable to scrutiny by the industries. Therefore, the Pavement Policy Committee is recommending that a central committee (subcommittee of the Pavement Policy Committee) be set up to review and concur with all pavement type selections in which the lowest life cycle cost alternative was not chosen. The goal is not to take away the decision making authority of the Districts, but rather support the Districts on these difficult pavement decisions. The main benefit will be that a record of these pavement decisions will be made and we can improve our decision logic in the future. The protocol and details for the committee functions are as follows:

Committee will consist of three members. The Pavement Design and Technology Engineer of the Office of Construction and two District Pavement Design Engineers. One district pavement design engineer will serve as an alternate on the committee. The District engineers will rotate semiannually.

If the project being reviewed is located in the same District as one of the members, that person will abstain from the recommendation process. The alternate will then be asked to participate.

If the project being reviewed is less than \$250,000 of paving, the decision is solely the province of the District and does not need to be reviewed by the committee. The \$250,000 amount will be closely monitored in order to assess the effectiveness of the committee based upon time constraints, review time, number of reports, etc.

The charge of this committee is to review all reports in which the selection is contrary to the results of the LCCA. The review will consist of a comparison to the policies presented within this report and the FDM, gain an understanding for the selection and help the District weigh the implications of the selection. The committee will then either recommend approval by the district or supply recommendations for revisions to the report and changes to the pavement type selection.

The committee will have five working days to review and issue a recommendation to the District.

In summary, a pavement type selection can be made in the following ways:

1. Life cycle costs results of the lowest PCC alternate and the lowest AC alternate are greater than 5 percent apart:

The lowest life cycle cost alternative is chosen based upon absolute difference in costs. The district will approve the report under current policies.

One or more of the "other considerations" is used to overrule the results of the LCCA and a more expensive alternative is chosen. If project contains more than \$250,000 of paving costs, prior to district approval of the report it must be reviewed by the Pavement Policy Committee's subcommittee.

2. Life cycle costs results of the lowest PCC alternate and the lowest AC alternate are less than 5 percent apart:

The lowest life cycle cost alternative is chosen based upon absolute difference in costs and all eight "other considerations" are considered and documented in the report. The district approves the report under current policies.

One or more of the other considerations overrule the results of the LCCA and a more expensive alternative is chosen. All eight "other considerations" are reviewed and documented in the report. If project contains more than \$250,000 of paving costs, prior to district approval of the report it must be reviewed by the Pavement Policy Committee's subcommittee.

IMPLEMENTATION

Implementation of the policies and guidelines presented in this report will be accomplished through publication in Chapter 14 on Pavements in the Facilities Development Manual. The effective date will be the date of publication in the manual. It will be required that all projects in which the Pavement Type Selection Report is approved after the publication conform to these policies. All projects in the design process with pavement type selection reports approved prior to the publication date will not be required to resubmit the pavement type selection, unless the original report requires adding or these policies are determined to benefit the project development. This will be at the discretion of the Districts.

The goal is to publish these policies and guidelines in the Facilities Development Manual by September 15, 1994. Training of the Divisions Pavement Design Engineers via the Pavement Structural Design Users Group would also be accomplished by that date. Education of the District and Central Office Design , Construction and Materials staff through direct district and office training sessions is also necessary. The goal is to complete that by October 15, 1994. Further education of the paving industries and consulting industries via committee and liaison meetings is the final step in implementation. The goal is to complete work with these groups by November 1, 1994.

PERFORMANCE MEASURES

The Pavement Policy Committee recommends that this effort be no different than the other major efforts within the Division of Highways. As part of our emphasis on quality, we must establish measures of performance in order to continually improve the quality of our work. To measure the success of the revised pavement type selection process, a three tiered approach will be undertaken. The first tier will involve a joint WisDOT/FHWA process review of the reports sent to Central Office files between 10/1/94 and 10/1/95. The purpose will be to determine the degree to which the new guidelines and policies are being used and followed by both districts and consultants. The second tier will involve interviews of district and consultant staff directly involved in the development of the pavement type selection reports. The purpose being to determine their feelings on the strengths and weaknesses of the guidelines and policies after one year of use. The third and final tier will involve industry interviews to once again identify the strengths and weaknesses of the new process from their perspective after one year of use. Upon completion of the process review and interviews, the comments will be reviewed by the Pavement Policy Committee and revisions to the guidelines and policies made as necessary.